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EFFECTS OF THE DRY SEASON ON GORILLA DIET IN GABON. ROGERS, M. E.[1], WILLIAMSON, E. A.[2], TUTIN, C. E. G., and M. FERNANDEZ[3].

It has been shown by various workers that lowland gorillas, *Gorilla g. gorilla*, in Gabon eat large quantities of succulent fruits (TUTIN and FERNANDEZ, 1985, WILLIAMSON, 1988, WILLIAMSON et al., 1988). This is work now being extended to include analysis of the nutrient content of fruit foods, and to study annual variations in fruit consumption caused by, for example, the major dry season from June to September.

Chemical Composition of Gorilla Foods

Table 1 shows the summarised results of analysing 23 species of fruit eaten by gorillas in the Lopé Reserve (0°10'S; 11°35'E). These include 12 of the 20 species occurring most frequently in gorilla faecal samples collected over the period between June 1985 - August 1987. Only those parts actually eaten are included; for example, if the skin of a fruit is discarded, its composition is not included. Fruits with very small seeds, which could not be easily removed, had to be analysed entire even though the seeds are not digested by gorillas (e.g. figs, *Ficus spp.*; wild guava, *Psidium*). Wherever possible, we excluded fruit parts that are not eaten, because we found that their composition was often quite different from parts consumed. The results show that, on average, gorillas eat fruits which are succulent, high in water-soluble sugars, and low in protein and fats.

Table 1: The average content nutrients, water and phenolics in fruits or fruit parts eaten by gorillas, expressed as % dry matter (water - % yet weight). Medians are given because they are a better indication of the central tendency than the mean value

COMPOSITION OF FRUITS OR FRUIT PARTS EATEN BY GORILLAS

	N	MEDIAN	RANGE
TOTAL PHENOLS	23	2.90	0.26-11.44
CONDENSED TANNINS	23	10.38	0.00-35.60
FIBRE (ADF)	23	22.45	4.84-44.19
CRUDE PROTEIN	23	5.01	1.23-8.36
SOL.SUGARS (WSC)	23	36.40	3.40-70.0
CRUDE LIPID	22	1.15	0.27-5.65
WATER	22	73.95	34.00-95.0

Table 2: As Table 1 for nine types of non-fruit foods. The parts eaten were leaves (from 6 species), bark (2 species) & pith (1 species)

COMPOSITION OF LEAF/STEM FOODS EATEN BY GORILLAS.

	N	MEDIAN	RANGE
TOTAL PHENOLS	9	1.44	0.41-7.74
CONDENSED TANNINS	9	1.78	0.00-21.67
FIBRE (ADF)	9	34.79	19.13-53.00
CRUDE PROTEIN	9	16.20	7.09-24.90
SOL.SUGARS (WSC)	9	2.20	0.15-10.60
CRUDE LIPID	7	1.15	0.40-3.58
WATER	9	72.00	55.00-88.50

However, variance is high; the range of fruits eaten is wide, and some contain large amounts of condensed tannins and phenols. The majority of gorilla fruit foods fall into the category of 'bird-monkey' fruits described by GAUTIER-HION et al. (1985), but a few belong in their other category of 'ruminant-rodent-elephant' fruits.

Table 2 shows the average chemical composition of 9 types of non-fruit foods (leaves, pith and bark) eaten by gorillas. These include samples from the three species most frequently found eaten at feeding sites on gorilla trails, that is *Megaphrynium ? gabonense* (young leaves); *Haumania liebrechtsiana* (young leaves); and *Aframomum sp.? nov.* (pith). Again, only those plant parts actually eaten contribute to the figures in the table. The results show that these foods are high in protein - only one of the samples (*Aframomum* pith) contained less than 10% crude protein - and low in soluble sugars, in contrast to the fruits analysed here.

Again there are gorilla foods which contain high concentrations of condensed tannins (Table 2). This would not have been expected from work on mountain gorillas, *Gorilla g. beringei* (WATERMAN et al., 1983), or from the only previous study which analysed lowland gorilla foods in West Africa (CALVERT, 1985). CALVERT, in fact, suggested that gorillas eat succulent fruit in order to avoid the high tannin content of the foliage of West African forests. This work shows that, not only do some of the fruits they eat have a high tannin content, but they also eat some of the high tannin foliage which they were supposed to avoid.

Gorilla Diet in the Dry Season

Rainfall in the Lopé Reserve is highly seasonal (Figure 1). Low rainfall corresponds with periods of fruit scarcity (WILLIAMSON, 1988). The major dry season, from June to September, is also a time when two important sources of leaf protein are reduced (Figure 2). Thus, two major nutrients -soluble sugars and protein- are less readily available to gorillas during the dry season. What happens to gorilla diet during this time? It might be predicted that they would stop eating fruit entirely, eat different and/or less fruit, or even emigrate to areas where fruit is still available. The evidence we have so far suggests that they adopt the second strategy, eating less fruit in combination with a generally more diverse folivorous diet. The evidence comes from observations of gorillas, from their trails, and from faecal samples.

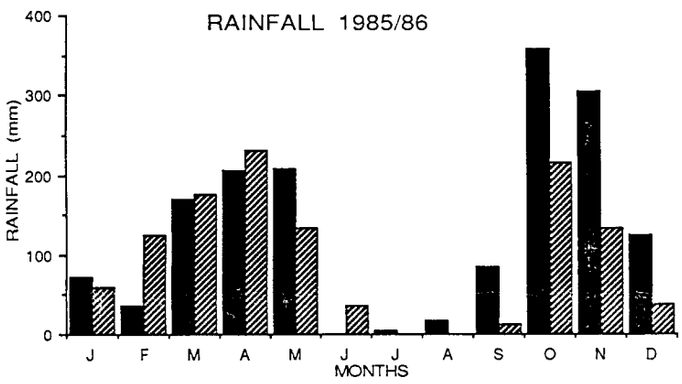


Fig. 1: Rainfall in mm at the Lope Reserve study site in 1985 (solid bars) and 1986 (hatched bars)

Analysis of all gorilla contacts where feeding was known to have occurred between June 1986 and May 1987 (N = 65) showed that in only 30% of those during the dry season (N = 27) were the animals feeding on fruit; whereas, in 68% of those during the rest of the year (N = 38) animals were feeding on fruit. This suggests a substantial decrease in fruit consumption during the dry season.

A systematic analysis of feeding sites on gorilla trails is still proceeding. This reveals considerable information about the foods used by gorillas when they are feeding on the ground, either on herbs or small trees. Fruit feeding is less easy to detect on trails, because it is usually done in large trees, and many other animals also feed on the same fruits, making it hard to distinguish gorilla activity from that of other species. From the information so far available, gorillas seem to eat a greater diversity of non-fruit foods during the dry season: twice as many species were recorded as fdoods more than ten times on trails in the 1986 dry season, as were recorded on trails during the following eight months (Oct. '86-May '87).

The most extensive information we have about gorilla diet during the year comes from faecal analysis. As was reported originally by TUTIN and FERNANDEZ (1985), we continue to find that the vast majority of faecal samples contain fruit remains (Table 3).

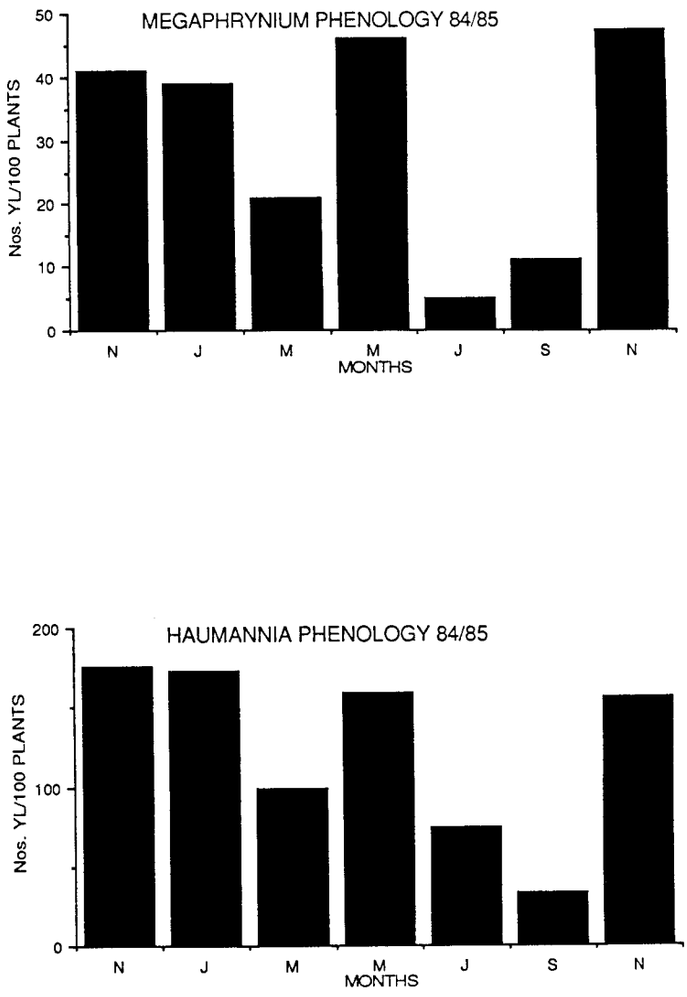


Fig. 2: Production of young leaves (YL) per 100 plants measured along a transect every two months from Nov. '84-Nov. '85 in two major species of food plants: (a) *Megaphrynium ? gabonense* & (b) *Haumania liebrechtsania* (family *Marantaceae*)

Table 3: The distribution of faecal samples with and without fruit remains in the dry season, compared with the non-dry season months

DATA FROM FAECAL ANALYSIS

June 1985 - August 1987

N = 1274

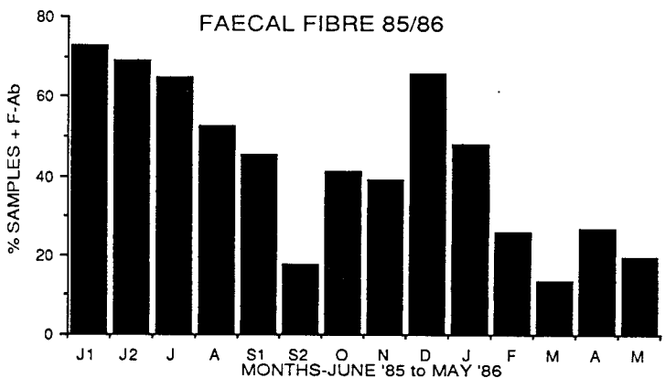
95.8% samples contain fruit remains.
4.2% samples contain no fruit remains.

	+ FRUIT	- FRUIT
DRY SEASON (June - Sept)	513	51
NON-DRY SEASON (Sept. - June)	708	2

G test; $p < 0.005$

99.4% of samples also contain fibre and/or green leaf fragments. Samples containing no fruit occur almost entirely in the dry season months; and those with the lowest mean diversity of fruit species also occur at this time. The number of faecal samples scored as containing 'abundant' fibre is also high during the dry season, although it may be high at other times too in some years (see 1985/86, Figure 3a). Thus, the indications are that gorillas become more folivorous, in the broadest sense, in the dry season.

Some fruit is eaten in the dry season. What sort of fruit is it? The species whose fruit was eaten most frequently during the 1985 and 1986 dry seasons was *Duboscia*, a large tree belonging to the family *Tiliaceae*. This fruit was eaten much less frequently during the other months of these two years. The data come from faecal analysis, which yields a rank order based on the frequency of occurrence of fruit remains of each species. Thus, the rankings for *Duboscia* were 1 ('85 and '86 dry seasons), compared with 9 ('85/'86 non-dry season) and 13 ('86/'87 non-dry season). *Duboscia* is a species which fruits outside the main community fruiting peaks (WILLIAMSON, 1988), but it is not a preferred food, as may be seen by the fact that its consumption during the dry season decreases whenever preferred fruits are available. This was the case during the 1987 dry season, when fruits of *Dialium* (*Caesalpiniaceae*) were available in large quantities through June and July, and were the fruit remains found most frequently in faecal samples. The consumption of *Duboscia* was low or non-existent from May through July 1987, and it only reappeared in faecal samples in August, by which time *Dialium* was no longer available.



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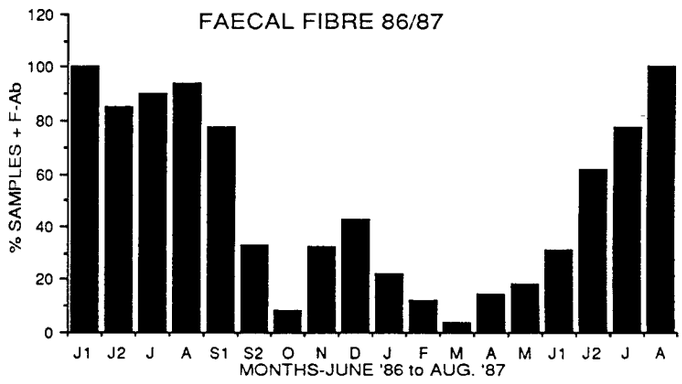

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Fig. 3: The monthly frequency of faecal samples containing abundant fibre (F-Ab) through two years, (a) 85/86 and (b) 86/87. J1, J2, S1 and S2 are the first and second halves of June (J) and September (S) respectively

Why might *Duboscia* be a less-preferred food? Perhaps it is because it is at the upper end of the range in fibre and tannin content (see Table 1). *Duboscia* has a fibre content of 43%, and a condensed tannin content of 33.5%. It also has a moderately low sugar content compared to most other fruit foods so far analysed (14.6%). However, lowland gorillas in Gabon must be well able to cope with fibrous, high tannin foods, because, as was mentioned before, several of their non-fruit foods also fall into this category, particularly some mature leaves and bark. Thus, during the 1986 dry season, gorillas were observed consuming large quantities of the mature leaves and bark of the tree *Chlorophora excelsa* (*Moraceae*), which contain respectively 20% and 22% condensed tannins. Consumption decreased at the end of the dry season. This again reinforces the conclusion that some foods used in the dry season contain more secondary compounds, and are probably less preferred, than non-dry season food species, which accords with the predictions of foraging theory as applied to primates (GAULIN, 1979).

There are other species besides *Duboscia* whose fruits are eaten during the dry season. These are mostly small understorey trees, shrubs and herbs, as well as some species growing in the savanna/forest edges (WILLIAMSON et al., 1988). Fruit is produced outside community fruiting peaks, but it is only ever available in small quantities. Thus, any one species contributes little to the bulk of fruit consumed. None of the fruits belonging to species in this category has yet been found to contain large quantities of condensed tannins.

Conclusions

Much remains to be done. For example, it is important to analyse the consumption of ants and termites by gorillas through the year (TUTIN and FERNANDEZ, 1983). The indications are that this also increases when fruit is scarce (TUTIN, personal observations).

It might be predicted that lowland gorillas would become more folivorous in the dry season, or at any time of fruit scarcity. Given the well-known folivory of mountain gorillas (FOSSEY and HARCOURT, 1977), this is not surprising. But, they do go on eating fruit of some sort, and the types of fruit that they eat would not have been predicted on the basis of work on mountain gorillas. Why continue to eat fruit, when what is available seems 'undesirable'? It may be because daily energy demands are most efficiently met by fruit consumption (LEIGHTON and LEIGHTON, 1983), and even the fruit of *Duboscia* has a higher sugar content at 14.6% than any of the non-fruit foods so far analysed. *Duboscia* trees are also common in the forest (WILLIAMSON, 1988), and therefore readily available.

The reaction of gorillas to seasonal fruit scarcity might be very important in determining the biomass of apes where chimpanzees are sympatric, as in Gabon. It could be that it is the ability of gorillas to increase the diversity of the non-fruit components of their diets, and in the process to consume 'undesirable' fruits and mature leaves, which differentiates them from chimpanzees when fruit is scarce. At other times, their diets can overlap considerably, as we now know from work in Gabon (TUTIN and FERNANDEZ, 1985 and 1987, WILLIAMSON, 1988).

Acknowledgements

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